hyperemia directly after release of the blood pressure cuff. As stated in our article, we did not measure reactive hyperemia but performed our measurements in all groups after 20 min of reperfusion. It is, therefore, unlikely that reactive hyperemia caused the observed differences between groups. We agree that further studies are needed to clarify more the mechanisms of helium preconditioning in human endothelium.

Kirsten F. Smit, M.D., Markus W. Hollmann, M.D., Ph.D., D.E.A.A., Nina C. Weber, Ph.D.,* Benedikt Preckel, M.D., M.A., D.E.A.A. *Academic Medical Center, University of Amsterdam, Laboratory of Experimental and Clinical Experimental Anesthesiology, Amsterdam, The Netherlands. n.c.hauck@amc.uva.nl

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Differentiating Inspiratory and Expiratory Valve Malfunctions

To the Editor:
We appreciate Dr. Kodali's recent review of capnography outside the operating room environment.[1]

Two small yet important details would benefit from further clarification. Figure 2C is purported to display the malfunction of an inspiratory valve in an anesthesia breathing circuit. Unlike a stuck, open expiratory valve, an inspiratory valve that remains open during expiration shows the end-tidal carbon dioxide baseline *returning to zero*.

The best way to understand this is to consider taking the circle system breathing circuit and removing the inspiratory valve entirely from the circuit. During expiration, one half of the exhaled carbon dioxide-rich gas will "exhale" into the inspiratory limb of the breathing circuit. With the next inhalation, roughly the first half of the inspired breath will contain this exhaled gas, and the last part of inspiration will be fresh gas from the absorber and the fresh gas flow, *i.e.*, carbon dioxide-free gas, which allows the capnogram to return to the zero baseline. Compared with the normal capnogram, with a competent inspiratory valve, the inspiratory downstroke will sluggishly return to a zero baseline (or a B angle greater than 90 degrees) as appropriately depicted in the cartoon in figure 2C. This subtle difference that occurs with the baseline returning to zero helps elucidate the difference between malfunctioning inspiratory and expiratory valves or exhausted carbon dioxide absorbent.

The second point is that in figure 3 A–D, the apparent presence of inspired carbon dioxide is an abnormal finding, and suggests that in this sedation case, there is evidence of rebreathing in the microenvironment around the face, which may occur as a result of draping. The normal inspired carbon dioxide during sedation is expected to be zero.

Chris Giordano, M.D.,* Nikolaus Gravenstein, M.D., Mark J. Rice, M.D. *University of Florida College of Medicine, Gainesville, Florida. cgiordano@anest.ufl.edu

Reference

1. Kodali BS: Capnography outside the operating rooms. Anesthesiology 2013; 118:192–201

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In Reply:
I thank the authors Giordano, Gravenstein, and Rice for their valuable comments on the subject of "Capnography Outside the Operating Rooms."[1] Due to the limitations of word count for "Clinical Concepts Commentary," a detailed account of each capnogram was not provided. Given the wider scope of electronic accessibility, the intention of the article was to provide a comprehensive review of the use of capnography outside operating rooms not only to anesthesiologists and certified registered nurse anesthetists, but also to physicians in other specialties and nurses who provide sedation. Therefore, the article was scripted to provide a concise physiologic background and clinical applications of capnography.

Giordano *et al.* raised important comments regarding capnograms 2C and 3A–D of the article.[1] Analysis of capnograms 2C and 3A–D in the aforementioned article is a little more complex than the explanation provided by Giordano *et al.* Regarding 2C, they state that the inspiratory downstroke will sluggishly return to a zero baseline (or a β angle >90 degrees) during inspiratory valve malfunction. This may be true in the typical circumstance described by Giordano *et al.*, where an assumption is made that half of the expiratory gases will enter the inspiratory limb. However in reality, the quantity of expiratory gases entering the inspiratory limb is dependent on the resistance to the flow of expiratory gases in each limb of the circuit. The resistance in turn is dependent on the design of the valves, extent of malfunction of the inspiratory valve, fresh gas flows, and the length of the circuit. In addition, the carbon dioxide concentration across the inspiratory limb is also dependent on turbulent *versus* laminar flow of expiratory gases and mixing of carbon dioxide–free fresh gases with expiratory gases in the inspiratory limb (expiratory gases do

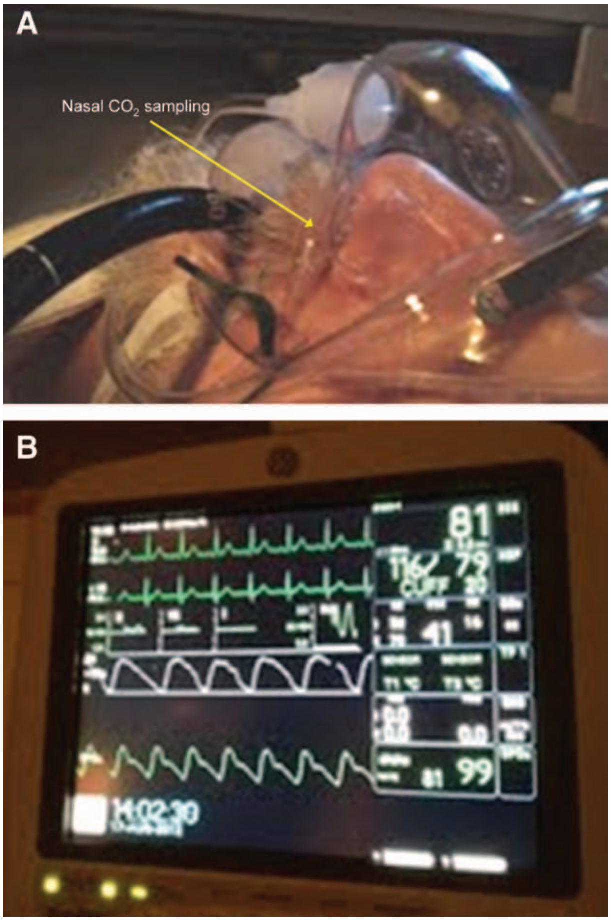

Fig. 1. Patient undergoing endoscopy. Supplementary oxygen was provided *via* the oxygen mask and expiratory carbon dioxide (CO_2) was sampled at the nostril by the nasal carbon dioxide sampling catheter device (*A*). Downstroke of capnograms reach zero base line suggesting no rebreathing of carbon dioxide (*B*).

not flow in blocks). For example, if malfunction of the inspiratory valve results in decreased resistance, it is conceivable that more than half of the expiratory gases might enter the inspiratory limb. This, in conjunction with the gas mixing between carbon dioxide–containing expiratory gases and carbon dioxide–free fresh gases may cause the final portion of the inspiratory tidal volume to contain certain amounts of carbon dioxide. Thus, the resulting downstroke of the capnogram (phase 0) will not reach the zero baseline. This was illustrated by me and my colleagues in a case report where we recorded capnograms during inspiratory valve malfunction and the subsequent inspiratory downstrokes did not reach the baseline.[2] However, it was also demonstrated by our group that capnograms can apparently appear normal despite substantial rebreathing resulting from inspiratory valve malfunction. However, when respiratory gas flows were superimposed on the capnograms, the significant rebreathing was obvious.[3]

Regarding capnogram 3A–D illustrated in the original article,[1] the morphology of capnograms depends, once again, on several factors. These include patient's respiratory rate, tidal volume, supplementary oxygen flow, gas leaks from the mask resulting in the carbon dioxide washout by the oxygen flow, and more importantly, the site of the carbon dioxide sampling. In capnograms 3A–D, the site of the sampling was adjacent to the inside wall of the mask *via* an adaptor, and not at the nostril. Therefore, the recorded carbon dioxide concentration does not represent the carbon dioxide concentration at the nostril. The morphology of the capnograms depends on the location of carbon dioxide sampling within the mask and on the washout of carbon dioxide by the supplementary oxygen flow. Unless carbon dioxide measurements are performed at the nostril, it may be difficult to ascertain whether there is rebreathing (although minimal). For example, figure 1A and B from this reply shows a patient undergoing upper gastroinstestinal endoscopy with supplementary oxygen provided *via* the mask, and end-tidal carbon dioxide monitoring was performed within the nostril using carbon dioxide sampling nasal cannula. The endoscope was inserted *via* a "U-shaped flap cut" in the mask. In this case, the carbon dioxide rebreathing was zero (fig. 1B) due to the carbon dioxide washout by supplementary oxygen at the nostril. Capnograms during sedation is a good subject for future discussion.

Bhavani Shankar Kodali, M.D., Harvard Medical School, Brigham and Women's Hospital, Boston, Massachusetts. bkodali@partners.org

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The Airway Paradigm: What Really Changed?

To the Editor:

In their recent study on airway assessment, Langeron *et al.*[1] described the results of their computer-scored examination as "paradigm changing." Although I believe they are correct in producing a paradigm change in the airway examination, I believe that the change actually arises from their methods rather than their results, and that the change is more significant than they suspected.

A key piece of methodology in this study, as in every study on airway examinations since Mallampati's 1985 article,[2]